

METABOLIC SYNDROME IN URBAN AND RURAL POPULATION OF GREATER NOIDA NATIONAL CAPITAL REGION OF INDIAMANOJ KUMAR SHARMA¹, SONALI PANDEY¹, SURYAKANT NAGTILAK^{2*}¹Department School of Sciences, JECRC University, Jaipur, Rajasthan, India, ²Department of Biochemistry, Sridev Suman Subharti Medical College, Subhartipuram, PO. Chandanwadi, Dehradun – 248 007, Uttarakhand, India. Email: nagtilak@yahoo.com

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ABSTRACT

Objective: The objective of this study was to evaluate the prevalence of metabolic syndrome (MetS) and to define its predictors in urban and rural patients presenting to tertiary care hospitals located in Greater Noida district Gautam Budh Nagar, India.

Methods: A total of 367 participants recruited in the study, aged 20–55 years, comprising, 290 patients (149 rural and 141 urban) and 77 healthy age, sex-matched controls from the study area. Anthropometric, clinical and laboratory examination information was obtained. MetS was defined as per the National Cholesterol Education Program, Adult Treatment Panel III (NCEP, ATP III) report.

Results: There were significant differences in biochemical and anthropometric measurements between control and patient population ($p < 0.05$). There was a substantial difference in the prevalence of MetS among male and female patient population of urban as well as rural areas. As per NCEP, ATP III criteria, the prevalence of MetS in urban patient population was 21.7% in male and 27.8% in female whereas rural male and female exhibited 13.8% and 18.8% of MetS, respectively. Waist circumference was found as the strongest predictor of MetS among the patient population.

Conclusion: Rapid urbanization of the cities is affecting the village life and indicating toward a major burden of diseases associated with MetS. A higher prevalence of MetS in female irrespective of the area of residence needs major health-care policy change. There is an urgent need to address this issue by adopting healthy eating, physical exercise, and weight reduction.

Keywords: Metabolic syndrome, Urban, Rural, Waist circumference, India, National Cholesterol Education Program, Adult Treatment Panel III.

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INTRODUCTION

Metabolic syndrome (MetS) is a group of clinical abnormalities, including obesity, high blood glucose, hypertension, low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), and high triglyceride levels. MetS is known to double the risk of cardiovascular disease (CVD) and increases the risk of type 2 diabetes mellitus by five-fold [1]. Pathophysiologically, MetS is associated with the insulin resistance which is produced by the fat stored in the body [2]. Free fatty acids released from adipose tissues are stored as triglycerides in liver [3] and further stimulates the production of LDL-C and very low-density lipoprotein cholesterol (VLDL-C). The increased amount of both LDL-C and VLDL-C tend to trigger the atherosclerotic plaque development in the blood vessels and finally to CVD [4]. Worldwide, India is in second place with 64.5 million cases of diabetes [5]. Similarly, in CVD age-standardized death rate in India is greater than average global data accounting for 272 deaths per 100 000 compared to 235 per 100 000 globally [6]. Considering the above occurrence rate one can estimate a higher prevalence rate of MetS in India. Studies carried out in different parts of India have shown variable prevalence and gender differences in MetS [7–9]. India is an agricultural based country where people living in rural areas are mostly involved in the agricultural activities which are predicted to have a low incidence of MetS. Contrary to the belief, studies conducted in various regions of India portraying a different figure [10–12]. The capital of India, Delhi is a metropolitan city which has its influence on the adjacent rural territories. The studies focusing on the effect of growing urbanization of Delhi on adjacent rural population have not been undertaken so far.

Hence, the current study is aimed to characterize the prevalence of MetS and associated risk in the urban and rural population residing in and around Greater Noida, adjoining to New Delhi. Anthropometric and

biochemical data were collected from the subjects. MetS was defined as per the National Cholesterol Education Program (NCEP), Adult Treatment Panel III (ATP III) report.

METHODS**Study design**

It was a cross-sectional study that recruited the patients coming to the outpatient department of tertiary care hospitals located in Greater Noida District Gautam Budh Nagar from February 2014 to January 2016. A total 290 patients (aged 20–55 years) were participated in the study among which 149 were from the urban area, and the rest were from rural area. The present study also recruited 77 age-matched healthy subjects (35 rural and 42 urban). The participants agreed to give informed consent were only recruited in the study. Ethical approval was taken from the Institutional Ethics Committee. For all the procedures, ethical guidelines of Helsinki (revised in 2000) were followed. All the participants with a known previous history of coronary heart disease and MetS were excluded from the study. Pregnant female and migrating population were also excluded from the study.

Anthropometric data

Height of the participants was measured using wall-mounted stadiometer with the movable headpiece. Participants were asked to remove their shoes before height measurements for correct reading. The weight of the participants was taken through the calibrated weight machine. Care was taken that the participants were not standing off-center on weighing balance. Participants were also asked to remove heavy clothing if any and shoes before taking their weight. Waist and hip circumferences were measured by standard procedures mentioned in the expert consultation report of the World Health Organization (WHO) published in 2008 [13]. Body mass index (BMI) was calculated

by dividing weight in kilogram/height in meter². Waist-hip ratio was calculated by dividing waist circumference with hip circumference.

Biochemical data

Venous blood samples were collected from the subjects in the morning after an overnight fast (8–10 h). Plasma fasting blood glucose (FBG) was measured using glucose oxidase-peroxidase method [10]. Cholesterol and triglycerides were measured using enzymatic cholesterol oxidase-peroxidase and glycerophosphate-oxidase (PAP) method, respectively [11,12]. HDL-C was measured using precipitation/ enzymatic method, and LDL-C was calculated using Friedewald's equation. Hemoglobin A1c (HbA1c) was processed by fluorescence immunoassay based technique with internal and external quality control.

Definition

MetS was defined as detailed in the NCEP, ATP III report, participants having three or more of the following of five factors [13]. Central obesity: Abdominal waist circumference, Male > 102 cm, Female >88 cm, serum triglycerides ≥150 mg/dl, serum HDL cholesterol-male <40 mg/dl, female <50 mg/dl, blood pressure ≥130/≥85 mm Hg, and FBG ≥110 mg/dl. The purpose of ATP III was to identify people who are at increased risk for CVD and to find out lifestyle intervention to reduce risk.

Statistical analysis

The data comparing anthropometric and biochemical parameters of patient and control were presented as mean±SD, and the prevalence was presented as a percentage. The data were compared using student's t-test. To investigate the associations of the different variables with MetS, Binary logistic regression analyses were performed. In all the statistical calculations p<0.05 were considered significant. All the statistical calculations were done using Statistical Package for the Social Sciences (SPSS) for Windows 16.0 software (SPSS Inc., Chicago, IL, USA).

RESULTS

Tables 1 and 2 show the mean values of biochemical and anthropometric parameters for control and patient group of male and female, respectively. Urban and rural male patients had an age ranging from 26 to 55 years. Similarly, control urban and rural male patients had an age from 23 to 50 and 24 to 54 years, respectively. As compared to control urban male, patients in the urban male group had a significantly higher level of all the variables (significantly lower HDL-C) except for blood pressure. Contrary to the finding for urban male, rural male patients were having a significant difference in the variables compared to control rural subjects except for diastolic blood pressure, FBG, and HDL-C. When urban male patients were compared to rural male

Table 1: Comparison of biochemical and anthropometric parameters among control and patient group of rural and urban male population (mean±SD)

Particulars	Control group		Patient group	
	Urban male (n=21)	Rural male (n=18)	Urban male (n=69)	Rural male (n=80)
Age in years	35.95±8.44	39.16±9.93	43.65±8.68	43.87±8.18
WC cms	80.00±3.97**	84.39±4.55	92.38±7.78 [†]	88.65±9.33 [#]
WHR	0.85±0.03	0.87±0.03	0.90±0.04 [†]	0.88±0.05 [#]
BMI kg/m ²	23.29±0.89	22.72±1.09	24.10±2.53*	23.50±2.18 [#]
BP systolic mmHg	127.52±2.69**	124.89±3.31	128.45±6.43	127.30±6.64 [#]
BP diastolic mmHg	82.14±2.22	82.00±1.81	83.61±5.01 [†]	81.56±4.45
FBG mg/dl	86.72±17.31**	96.83±7.43	105.20±25.02*	101.62±19.14
Cholesterol mg/dl	177.68±16.21	172.28±17.87	196.00±43.15*	184.43±33.27 [#]
Triglyceride mg/dl	139.93±5.71	135.53±10.20	163.48±83.65*	151.09±54.18 [#]
HDL-C mg/dl	50.00±5.10	47.58±5.54	44.19±7.97*	45.50±7.03
LDL-C mg/dl	99.63±18.60	97.57±17.77	119.65±43.91*	111.71±34.39 [#]
VLDL-C mg/dl	27.98±1.15	27.10±2.04	32.68±16.74*	30.23±10.83 [#]
HbA1c %	4.64±0.32**	5.07±0.60	5.64±1.18*	5.56±1.10 [#]

*Urban male patient compared to control urban male, [#]rural male patient compared to control rural male, [†]urban male patient compared to rural male patient, **control urban male compared to control rural male, t-test between groups, level of significance at p<0.05. WC: Waist circumference, WHR: Waist/hip ratio, BP: Blood pressure, LDL-C: Low-density lipoprotein cholesterol, HDL-C: High-density lipoprotein cholesterol, VLDL-C: Very low-density lipoprotein cholesterol, FBG: Fasting blood Glucose, HbA1c: Hemoglobin A1c, SD: Standard deviation

Table 2: Comparison of biochemical and anthropometric parameters among control and patient group of rural and urban female population (mean±SD)

Particulars	Control group		Patient group	
	Urban female (n=21)	Rural female (n=17)	Urban female (n=72)	Rural female (n=69)
Age in years	37.76±10.97	35.88±9.49	42.66±9.34	43.95±8.78
WC cms	81.43±5.20	83.12±4.06	89.61±9.30\$ [%]	86.96±5.26 [@]
WHR	0.82±0.03	0.82±0.02	0.85±0.06 [§]	0.85±0.06 [@]
BMI kg/m ²	23.23±1.29	23.63±1.04	24.43±2.34 [§]	23.96±2.15
BP systolic mmHg	125.57±3.26	125.76±3.46	130.64±7.02 ^{§%}	127.65±5.57
BP diastolic mmHg	81.81±2.06 ^{##}	80.47±1.50	84.26±5.30 [§]	84.54±4.16 [@]
FBG mg/dl	88.36±8.24	93.38±8.01	108.08±27.56 [§]	102.79±21.43 [@]
Cholesterol mg/dl	176.31±18.53	165.95±19.53	192.42±39.05 [§]	192.85±44.64 [@]
Triglyceride mg/dl	131.21±17.42	132.87±12.39	158.89±86.96 [§]	154.95±57.81 [@]
HDL-C mg/dl	54.94±2.97 ^{##}	53.16±2.08	48.85±8.82 [§]	49.28±7.40 [@]
LDL-C mg/dl	95.15±19.43	84.74±16.71	111.83±40.36 [§]	113.77±45.41 [@]
VLDL-C mg/dl	26.24±3.48	26.56±2.47	31.77±17.39 [§]	30.98±11.57 [@]
HbA1c %	4.55±0.58	4.69±0.38	5.86±1.42 [§]	5.60±1.42 [@]

[§]urban female compared to control urban female, [@]rural female compared to control rural female, [%]urban female patient compared to rural female patient, ^{##}control female urban compared to control rural female, t-test between groups, level of significance at p<0.05. WC: Waist circumference, WHR: Waist/hip ratio, BP: Blood pressure, LDL-C: Low-density lipoprotein cholesterol, HDL-C: High-density lipoprotein cholesterol, VLDL-C: Very low-density lipoprotein cholesterol, FBG: Fasting blood Glucose, HbA1c: Hemoglobin A1c, SD: Standard deviation

patients than they were found to have a significantly higher waist circumference, waist-to-hip ratio, and diastolic blood pressure. To ascertain the difference in the levels of the variables among urban and rural male controls, they were compared, and urban control subjects were found to have a lower waist circumference, blood glucose, HbA1c, and higher systolic blood pressure.

Similar to the male population, urban and rural female patients were also compared to control urban and rural female patients. The age of urban and rural female patients was ranging from 24 to 55 and 23 to 55 years, respectively. The age of the control urban female patients was from 21 to 53 years and of rural female from 24 to 53 years. All the tested variables for the urban female patients were significantly different from urban control female subjects. Rural female patients were also having a significant difference in the variables compared to control rural patients except for the BMI and systolic blood pressure. Urban female patients had a significantly higher waist circumference compared to rural female patients. In control group, urban females were having significantly higher HDL-C and systolic blood pressure compared to the rural counterpart.

Table 3 represents the percentage prevalence for the ATP III criteria. When the patient population was screened as per the NCEP, ATP III definition than around 62% urban male patients were found to have one or more criteria of ATP III. In contrast to it, approximately 52.5% of rural males were not having any of the ATP III criteria. A lower percentage of urban female patients (31.9) had none of the ATP III criteria. Compared to urban females, 44.9% rural female patients were found not to have any criteria positive for MetS as per the ATP III definition. Interestingly, nearly equal percentage of the urban and rural female patients had all the five criteria of the ATP III. Contrary to it, only 5% of rural males were found to possess all the five criteria compared to urban males where 13% of the study population had all ATP III criteria.

According to the definition of the NCEP ATP III subjects having three or more criteria are known to have MetS. When our patient population was computed for the prevalence rate of MetS as per the NCEP ATP III than rural males were found to have 13.8% MetS. Urban males were found to have 1.5 times higher prevalence of MetS. Both urban and rural female patients were having a higher prevalence of MetS compared to their male counterparts (Table 4).

To know the determinants of MetS among patients logistic regression was done. Binomial logistic regression model after age and gender adjustment was used for the analysis of the data. MetS was selected as a dependent variable, and ATP III criteria components FBG, waist circumference, triglyceride, HDL-C, and systolic and diastolic blood pressure were chosen as independent variables. Among variables, waist circumference was the strongest determinant of the MetS with odds ratio (OR) 1.57 ($p < 0.05$). Although the odds of the diastolic blood pressure were in second place (OR 1.42), the value was found non-significant. Other significant variables with OR in decreasing order were FBG and HDL-C (Table 5).

DISCUSSION

MetS is a multifactorial clinical condition where each of its factors plays a crucial role in the development of clinical disorders such as diabetes and CVD [14]. In addition to diabetes and CVD, numerous clinical studies have also found the association of MetS with other disorders such as sleep-disordered breathing, polycystic ovary syndrome, and some cancer types [15–19].

MetS is known to have a link with socioeconomic, cultural and environmental conditions of the population studied. In this context, India has the varied distribution of the population as per cultural, environmental and socioeconomic status [20]. In India, almost 70% of the population live in rural areas which exhibit a substantial difference in the food habit and living environment compared to urban [21]. The

Table 3: Prevalence (%) of different factors (NCEP ATP III) among rural and urban patient population

Number of factors (NCEP ATP III)	Urban male	Rural male	Urban female	Rural female
0	37.7	52.5	31.9	44.9
1	21.7	23.8	31.9	30.4
2	18.8	10	8.3	5.8
3	5.8	5	4.2	4.3
4	2.9	3.8	8.3	0
5	13	5	15.3	14.5

NCEP: National Cholesterol Education Program, ATP III: Adult Treatment Panel III

Table 4: Total prevalence (%) of MetS among urban and rural patient population

Particulars	Urban male	Rural male	Urban female	Rural female
MetS prevalence	21.7	13.8	27.8	18.8

MetS: Metabolic syndrome

Table 5: Binomial logistic regression using MetS as a dependent variable and other components as independent variables

Particulars	OR	Lower CI	Upper CI	Significance
FBG	1.087	1.022	1.156	0.008
Triglyceride	1.02	0.996	1.046	0.104
HDL-C	0.765	0.617	0.949	0.015
Waist circumference	1.57	1.181	2.088	0.002
BP systolic	1.165	0.982	1.381	0.08
BP diastolic	1.427	0.991	2.055	0.056

OR: Odds ratio, CI: Confidence interval, FBG: Fasting blood glucose, HDL-C: High-density lipoprotein cholesterol, FBG: Fasting blood Glucose, BP: Blood pressure

national capital of India, Delhi, has a modernized living culture that is affecting its adjacent rural areas as well.

This study is focused on the Gautam Budh Nagar province, which includes rapidly growing urban area of Greater Noida and adjacent rural villages. We focused our study on the urban and the rural patient population of the area. There was an approximately equal number of urban male and female and their rural counterparts. This study also recruited control urban and rural subjects, although the number of subjects in the control group was not comparable to the patient population, it was done to access the anthropometric and biochemical data of normal population of the province. It is clear from the results comparing control and patient population that both urban and rural patient population had a significant difference in nearly all the parameters studied. Interestingly, both urban male and female patients had a significantly high waist circumference compared to rural male and female counterparts. The logistic regression analysis also revealed waist circumference as a determinant of the MetS.

Although BMI is considered as the best predictor of the obesity, overlooks central obesity and discriminates poorly between lean mass and fat. It has been seen in various studies that parameter other than BMI for obesity is superior for Asian-Indian population [22,23]. One of the reason is that Indians have higher visceral fat mass than other population with similar BMI. Studies have shown the development of metabolic abnormality even at lower BMI [24]. Considering the facts, the current study excluded the BMI during risk factor analysis for MetS.

This study further found the higher prevalence of the MetS among the female irrespective of their place of residence; however, rural

female patients had a lower prevalence of MetS compared to urban female. Several studies conducted across India revealed similar results [7,21,25,26]. Study done by Prabhakaran *et al.* considering zonal population from Delhi as urban and residents from Ballabgarh (35 km south from Delhi) as rural found a higher prevalence of MetS in urban male and female compared to the present study. Moreover, they found a lower prevalence rate of MetS among their rural male and female participants [26]. The difference in the prevalence between the studies could be attributed to the time of the study (a difference of almost a decade exists between the studies) and its sample size.

Higher prevalence of the MetS among women found in the current study could be attributed to the nature of the work as most of the women do household work that includes less physical activity [27–29]. In fact, the urban population (both male and female) had a higher prevalence rate of MetS compared to rural counterpart which could be the outcome of their eating habit, stress, and sedentary lifestyle [10,26,30].

The second predictor of MetS in the current study was FBG which has the association with the abdominal fat. The finding of the waist circumference as the strongest predictor in the current study further validates the outcome of the regression analysis. Pathophysiologically increased release of non-essential fatty acids (NEFA), hormones such as leptin and adiponectin, glycerol, and pro-inflammatory cytokines from adipose tissues causes insulin resistance that leads to increase in blood glucose and produces diabetes [31–33].

The limitation of this study was that control sample size was small which could not be significant to provide a generalized MetS prevalence data. Moreover, the number of patients recruited is less to provide a comprehensive representation of Gautam Budh Nagar province.

To conclude our study, rapid urbanization is greatly affecting the lives of the residents of the area and even affecting lives in the villages. The present study was conducted to examine such changes in the Gautam Budh Nagar and found to affect both urban and rural populations. Moreover, the female patient population was found to have higher MetS compared to male patients.

CONFLICTS OF INTEREST

The author declares there are no conflicts of interest.

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AUTHOR'S CONTRIBUTION

Manoj Kumar Sharma has contributed to conception and design, acquisition of manuscript work to this study, literature search and analysis of the data. Dr Sonali Pandey and Dr. Suryakant Nagtilak have contributed to interpretation of data, drafting the article and gave the final approval for submitting the article.

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